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ANALYSIS OF FIRST TERRASAR-X ALONG-TRACK INSAR-DERIVED SURFACE CURRENT FIELDS

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We present the first analysis of surface current fields derived from TerraSAR-X along-track interferometric SAR (along-track InSAR, ATI) data. The data were acquired over the lower Elbe river, Germany, during six satellite overpasses in spring and summer 2008, using the experimental "aperture switching" (AS) mode of TerraSAR-X. In the AS mode, the phased-array SAR antenna is split into two halves for receiving, but in contrast to the "dual receive antenna" (DRA) mode, which uses two independent receivers in parallel, a single receiver is multiplexed to process signals from the two antenna halves in an alternating way. The required increase of the pulse repetition frequency by a factor of 2 results in a corresponding reduction of the effective swath width to about 15 km in stripmap mode. The effective ATI baseline is on the order of 0.8 m, corresponding to a time lag of 0.1 ms. More technical details of the AS mode of TerraSAR-X may be found in the paper by *Runge et al.* [2006]. The interferometric processing of AS mode data is described in the paper by *Suchandt et al.* [2009], to be presented in the same IGARSS session as this paper.

The ATI technique exploits phase differences between two SAR images acquired by two antennas with a short time lag. These phase differences are proportional to the Doppler shift of the backscattered signal and permit direct line-of-sight target velocity retrievals. After several successful airborne ATI experiments in the late 1980s and the 1990s, the feasibility of high-resolution current measurements from space by ATI was first demonstrated with an image of the Dutch Wadden Sea from the Shuttle Radar Topography Mission (SRTM) in February 2000 [*Romeiser et al.*, 2005]. Despite clearly suboptimal instrument parameters, an accuracy of 0.1 m/s was obtained at an effective spatial resolution (resulting from averaging over many pixels of the original image for noise reduction) of about 1 km. A second SRTM image, showing the lower Elbe river between Hamburg (Germany) and the North Sea, was analyzed in the paper by *Romeiser et al.* [2007], which also includes a discussion on the general suitability of spaceborne ATI systems and the specific suitability of TerraSAR-X for current measurements in rivers. A more fundamental analysis of the theoretical ATI performance of TerraSAR-X in different modes of operation was presented by *Romeiser & Runge* [2007].

This paper focuses on the conversion of Doppler velocity maps into surface current fields (elimination of ship signatures and imaging artifacts, filtering, correction for contributions of wave motions) and a quantitative evaluation of the data quality. The TerraSAR-X derived currents are compared with available in-situ data, numerical flow model results, and simulated ATI data products. The ATI performance of TerraSAR-X is found to be basically consistent with theoretical expectations. Most of the observed differences between TerraSAR-X derived currents and reference currents can be attributed to known shortcomings of our preliminary data processing algorithms, such as uncertainties in the absolute phase calibration and in estimates of contributions of wave motions to measured Doppler velocities in rivers. Furthermore, the flow model data used in this study do not necessarily represent a perfect ground truth. All of these issues will be addressed with planned algorithm improvements and with dedicated in-situ measurements of currents, winds, and waves during upcoming TerraSAR-X ATI data acquisitions for a very comprehensive model calibration and validation. Based on the results obtained so far, we are very optimistic to meet our internal performance goal of a typical current measuring accuracy of 0.1 m/s at an effective spatial resolution of 1000 m with AS mode data and an even better accuracy and spatial resolution with DRA mode data.

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